

What is claimed is:

- 1 1. A device for viewing an object with a probe, comprising:
2 image splitting means for splitting an image of said object into first and
3 second adjacent stereo image parts;
4 image detecting means for detecting said stereo image parts; and
5 focusing means for focusing said two stereo image parts from said image
6 splitting means to said image detecting means; wherein said focusing means includes
7 only one optical axis.
- 1 2. A device according to claim 1, wherein views of said first and second stereo image
2 parts converge at a given object distance such that said views overlap 100% at said
3 object distance.
- 1 3. A device according to claim 1, wherein said image splitting means includes a
2 refractive image splitting prism.
- 1 4. A device according to claim 1, wherein said first and second image parts are
2 non-symmetrical.
- 1 5. A device according to claim 1, wherein said first and second image parts are
2 symmetrical.
- 1 6. A device according to claim 3, wherein said refractive image splitting prism is
2 contained within a detachable distal tip of said device.
- 1 7. A device according to claim 3, further comprising a window disposed between said
2 prism and said object, wherein contact is prevented between external media and said
3 image splitting prism.

1 8. A device according to claim 1, further comprising display means for viewing said
2 stereo image parts as detected by said image detecting means.

1 9. A device according to claim 8, wherein only one of said stereo image parts is
2 displayed.

1 10. A device according to claim 8, further comprising viewing means for viewing
2 said first and second image parts such that a right-hand part goes to a right eye of a
3 viewer, and a left-hand part goes to a left eye of said viewer; wherein said viewer is
4 provided with a three dimensional perspective.

1 11. A device according to claim 8, wherein at least one of first and second portions of
2 said image are displayed at a different magnification from said first and second image
3 parts, with both said at least one of first and second portions and said first and second
4 image parts being displayed concurrently.

1 12. A device according to claim 1, further comprising measuring means for
2 comparing parameters of said first and second stereo image parts so that measurement
3 data of said object are determined, wherein said measurement data includes at least
4 one geometric characteristic of said object.

1 13. A device according to claim 12, further comprising an optical characteristics data
2 set used by said measuring means to determine said measurement data.

1 14. A device according to claim 13, wherein a user is signaled if a difference between
2 said optical characteristics data set and global alignment data determined from said
3 image exists.

1 15. A device according to claim 12, wherein said device is effective for receiving one
2 of a plurality of detachable distal tips, wherein each of said detachable tips has a
3 corresponding optical characteristics data set, and wherein data determined from said

4 image is used to select which optical characteristics data set corresponds to said
5 detachable tip emplaced in said probe.

1 16. A device according to claim 12, wherein said device is effective for using one of a
2 plurality of probes, wherein each of said probes has a corresponding optical
3 characteristics data set, and wherein data determined from said image is used to select
4 which optical characteristics data set corresponds to said probe includes in said
5 device.

1 17. A device according to claim 13, further comprising calibration means for
2 generating said optical characteristics data set of said device, wherein said calibration
3 means includes a plurality of object target points which appear in both of said first
4 and second stereo image parts when viewed with said probe.

1 18. A device according to claim 17, wherein said calibration means includes means
2 for color balancing.

1 19. A device according to claim 17, wherein said plurality of object target points
2 consists of at least two points with known spacing between them at a first object
3 target distance and at least two points with known spacing between them at a second
4 object target distance, wherein a distance between said first and second object target
5 distances is known.

1 20. A device according to claim 17, wherein said plurality of object target points
2 consists of at least two points with known spacing between them at a first object
3 target distance and at least one point at a second object target distance, wherein a
4 distance between said first and second object target distances is known, and wherein
5 one of said first and second object target distances is known.

1 21. A device according to claim 17, wherein said optical characteristics data set
2 includes optical mapping distortion, magnification at one or more object target

3 distances, and parallax information, wherein said calibration means generates said
4 optical characteristics data set from only one image.

1 22. A device according to claim 17, further comprising means for automatic detection
2 and identification of said plurality of object target points.

1 23. A device according to claim 17, wherein calibration means includes using a
2 reflection of illumination at at least one known object target distance.

1 24. A device according to claim 13, wherein said optical characteristics data set is
2 stored in non-volatile memory in said probe.

1 25. A device according to claim 13, wherein said optical characteristics data set and
2 said first and second image parts are stored in a single file.

1 26. A device according to claim 13, further comprising adjusting means for adjusting
2 said optical characteristics data set of said device to increase the accuracy of said
3 measurement data when a distal portion of said probe is operated in a medium with an
4 index of refraction which differs from that of air.

1 27. A device according to claim 12, wherein said measuring means includes matching
2 means for matching a same point viewed on said object in each of said stereo image
3 parts.

1 28. A device according to claim 27, wherein said matching means includes automatic
2 matching means for automatic matching of a user designated point viewed on said
3 object in said first image part to a corresponding point in said second image part.

1 29. A device according to claim 28 wherein said automatic matching means includes
2 means for requesting user selection of a correct matched point from a plurality of
3 automatically-identified possible matches.

1 30. A device according to claim 28, wherein, when a position of said user-designated
2 point on said viewed object in said first image part is changed by said user, said
3 automatic matching dynamically occurs without further user intervention.

1 31. A device according to claim 28, wherein said automatic matching means includes
2 global alignment means for performing an automatic global alignment of said first and
3 second image parts.

1 32. A device according to claim 31, wherein said global alignment means includes
2 means for determining a global vertical shift between said first and second image
3 parts.

1 33. A device according to claim 31 wherein said global alignment means includes
2 means for automatically determining one or more regional horizontal shifts between
3 said first and second image parts.

1 34. A device according to claim 31 wherein said global alignment means uses the
2 positions of one or more user-designated matched points in said first and second
3 image parts to aid in performing said global alignment.

1 35. A device according to claim 31 wherein a correction by a user of an incorrect
2 automatic match automatically invokes said global alignment means.

1 36. A device according to claim 31, wherein data derived from said global alignment
2 means is used to make said automatic matching of said matching means faster than
3 otherwise.

1 37. A device according to claim 31, wherein data derived from said global alignment
2 means is used to reduce a probability of incorrect matches of subsequent user-defined
3 points.

1 38. A device according to claim 31, further comprising means, based on data derived
2 from said global alignment means, for determining and conveying to a user an overlap
3 region of said stereo image parts in which measurements are performed.

1 39. A device according to claim 12, wherein said measuring means includes means
2 for indicating a measurement accuracy of said measurements.

1 40. A device according to claim 39, wherein said measuring means includes means
2 for an operator to designate a maximum estimated error limit above which said device
3 indicates a warning.

1 41. A device according to claim 12, wherein said measuring means includes means
2 for using at least first and second images of said object to determine said
3 measurement data when a view of said object is not contained entirely within said first
4 image.

1 42. A device according to claim 12, wherein said measuring means includes means
2 for providing a distance to said object to enhance a focus of said image using
3 deconvolution techniques.

1 43. A device according to claim 12, further comprising means for assembling a
2 plurality of points in a given area and structuring three dimensional information of
3 said points into a finished file which permits reconstructing at least one geometric
4 characteristic of said image.

1 44. A device according to claim 12, wherein said measuring means includes using at
2 least one onscreen cursor.

1 45. A device according to claim 44, wherein said measuring means includes means
2 for displaying a symbol, which indicates both a type of measurement being performed
3 and a role of said cursor in said type of measurement.

1 46. A device according to claim 44, wherein at least one measurement point
2 designated by a user when performing one type of measurement is kept even when a
3 different type of measurement is selected.

1 47. A device according to claim 12, wherein said measuring means includes:
2 means for projecting a pattern from an off-imaging axis onto said object being
3 viewed such that said pattern tracks across said object relative to a distance of said
4 object from said device; and
5 means for using a location of said pattern on said object to aid determination
6 of said measurement data.

1 48. A device according to claim 12, wherein said image and said determined
2 measurements are stored in a single file.

1 49. A device according to claim 12, wherein said measuring means includes means
2 for taking a series of measurements from different perspectives, which are used to
3 obtain a more accurate measurement than by taking a measurement from only one
4 perspective.

1 50. A method for viewing an object with a probe, comprising the steps of:
2 splitting an image of said object into first and second adjacent stereo image
3 parts;
4 detecting said stereo image parts; and
5 focusing said two stereo image parts from said image splitting means to said
6 image detecting means; wherein said step of focusing uses only one optical axis.

1 51. A method according to claim 50, further comprising the step of converging views
2 of said first and second stereo image parts at a given object distance such that said
3 views overlap 100% at said object distance.

1 52. A method according to claim 50, wherein said step of splitting uses a refractive
2 image splitting prism.

- 1 53. A method according to claim 52, further comprising the step of placing said
2 refractive image splitting prism within a detachable distal tip of said borescope or
3 endoscope.
- 1 54. A method according to claim 52, further comprising the step of disposing a
2 window between said prism and said object wherein contact is prevented between
3 external media and said prism.
- 1 55. A method according to claim 50, further comprising the step of viewing said
2 stereo image parts as detected by the step of detecting.
- 1 56. A method according to claim 55, further comprising the step of displaying only
2 one of said stereo image parts.
- 1 57. A method according to claim 55, further comprising the step of viewing said first
2 and second image parts such that a right-hand part goes to a right eye of a viewer, and
3 a left-hand part goes to a left eye of said viewer; wherein said viewer is provided with
4 a three dimensional perspective.
- 1 58. A method according to claim 50, further comprising the step of comparing
2 parameters of said first and second stereo image parts to determine measurement data
3 of said object.
- 1 59. A method according to claim 58, further comprising the step of determining at
2 least one geometric characteristic of said object.
- 1 60. A method according to claim 58, further comprising the step of generating an
2 optical characteristics data set of said probe by comparing a known set of object target
3 points.

1 61. A method according to claim 60, further comprising the step of using said optical
2 characteristics data set to determine said measurement data.

1 62. A method according to claim 60, further comprising the step of storing said
2 optical characteristics data set in non-volatile memory in said probe.

1 63. A method according to claim 60, further comprising the step of adjusting said
2 optical characteristics data set so that said probe is operable in a medium with an
3 index of refraction other than air.

4 64. A method according to claim 60, wherein said step of generating an optical
5 characteristics data set includes color balancing.

1 65. A method according to claim 60, wherein said set of known object target points
2 consists of at least two points at a first object target distance and at least one point at a
3 second object target distance.

1 66. A method according to claim 60, further comprising generating said optical
2 characteristics data set from said first and second stereo image parts, wherein said
3 optical characteristics data set includes optical mapping distortion and magnification
4 at one or more object target distances.

1 67. A method according to claim 60, further comprising the step of automatically
2 detecting and identifying said known set of object target points.

1 68. A method according to claim 60, wherein said step of generating said optical
2 characteristics data set includes using a reflection of illumination at at least one
3 known object target distance.

1 69. A method according to claim 58, further comprising the step of matching a same
2 point in each of said stereo image parts.

1 70. A method according to claim 69, further comprising the step of automatically
2 matching a user designated point from said first image part to said second image part.

1 71. A method according to claim 70, wherein said step of automatically matching
2 includes performing a global alignment of said first and second image parts.

1 72. A method according to claim 71, wherein said step of performing said global
2 alignment includes determining a global vertical shift between said first and second
3 image parts.

1 73. A method according to claim 71, wherein said step of performing said global
2 alignment includes determining one or more regional horizontal shifts between said
3 first and second image parts..

1 74. A method according to claim 71, wherein data derived from the step of
2 automatically matching at least one matched point in said stereo image parts is used to
3 make the step of automatically identifying at least one user defined point from said
4 first image part to said second image part complete faster than otherwise.

1 75. A method according to claim 69, wherein said step of matching includes the step
2 of automatically identifying at least one matched point in said stereo image parts.

1 76. A method according to claim 75, wherein data derived from the step of
2 automatically identifying at least one matched point in said stereo image parts is used
3 to reduce a probability of incorrect matches of subsequent user-defined points.

1 77. A method according to claim 75, further comprising the step of determining and
2 conveying to a user an overlap region of said stereo image parts in which
3 measurements are performed.

1 78. A method according to claim 58, wherein the step of comparing parameters
2 includes the step of indicating a measurement accuracy of said measurements.

1 79. A method according to claim 78, wherein the step of comparing parameters
2 includes enabling an operator to designate a maximum estimated error limit above
3 which limit said device indicates a warning to said operator.

1 80. A method according to claim 58, wherein the step of comparing parameters
2 includes the step of using multiple images of said object to determine said
3 measurement data when a view of said object is not contained entirely within one
4 image.

1 81. A method according to claim 58, wherein the step of comparing parameters
2 includes the step of providing a distance to said object to enhance a focus of said
3 image using deconvolution techniques.

1 82. A method according to claim 58, further comprising the steps of:
2 assembling a plurality of points in a given area; and
3 structuring three dimensional information of said points into a finished file
4 which permits reconstructing at least one geometric characteristic of said image.

1 83. A method according to claim 58, wherein the step of comparing parameters
2 includes using at least one onscreen cursor.

1 84. A method according to claim 58, wherein the step of comparing parameters
2 includes the steps of:
3 projecting a pattern from an off-imaging axis onto said object being viewed
4 such that said pattern tracks across said object relative to a distance of said object
5 from said method; and
6 using a location of said pattern on said object to aid determination of said
7 measurement data.

1 85. A method according to claim 58, further comprising storing said image and said
2 determined measurements in a single file.

1 86. A method according to claim 58, wherein the step of comparing parameters
2 includes taking a series of measurements from different perspectives, and using said
3 measurements to obtain a more accurate measurement than by taking a measurement
4 from only one perspective.